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THE CERTIFICATION PLAN

"Willing-to-Certify Sources of Supply" are lists of manufacturers who have expressed their desire to supply material on contracts based on certain selected Federal specifications, and their willingness to certify to the purchaser, *upon request*, that the material thus supplied is guaranteed to comply with the requirements and tests of the indicated specifications. These lists have been compiled by G. W. Wray of the Bureau's Codes and Specifications Division for distribution to tax-supported purchasing agencies.

The earlier lists of willing-to-certify sources of supply, designated as Bureau of Standards Letter Circulars LC256 and LC256a (a revision of LC256), and their supplements nos. 1 and 2 are out of print, and copies thereof are no longer available. These lists have been superseded by the "supplements" listed below, which, in addition to containing new lists of willing-to-certify firms in certain designated groups, include revisions of the earlier lists in these groups.

Further information concerning the application of the certification plan or any other phase of the work on standardization, including the labeling plan, may be obtained from the Division of Codes and Specifications, National Bureau of Standards, Washington, D. C.

Supplement	Products
1A	Includes recently prepared lists of manufacturers of: Animal products; cable and wire; drugs and medicines; electric apparatus; instruments; paints, pigments, varnishes, and related products; petroleum and products; rubber and rubber goods; vegetable products; and wood products.
2A	Reserved for lists to be prepared during 1937.
3	Softwood lumber and timber manufacturers, wholesalers, and retailers.
4	Brooms and brushes.
5	Chemicals, cleaning, and polishing materials.
6	Coal and products, coal tar and products, and insulating materials.
7	Ceramics, furniture, glass and glassware, and hardware.
8	Office paste, leather, inks, and paper.
9	Instruments, machinery, pipe, pipe-fittings, plumbing fixtures, tubes and tubing (metallic), scales, and tools.
10	Minerals and products (including asphalt, brick, cement, gypsum, lime, plaster, refractories, roofing, tile, etc.).
11	Metals and metal products.
12	Cordage and textiles.

COMMERCIAL STANDARD FOR DOUGLAS FIR PLYWOOD (DOMESTIC GRADES)

Commercial Standard CS45–36, Douglas Fir Plywood (Domestic Grades) (Second Edition), which has just been released, is a revision of the basic standards developed several years ago for this product, and embraces certain changes that have proved desirable. It became effective November 1, 1936.

The publication covers only Douglas fir plywood as made for the domestic trade, and includes general requirements concerning workmanship, construction, gluing, loading, and packing.

Grading specifications are given in detail that delineate the several kinds of plywood panels, industrial stock, and concrete form material that are offered for sale, while the standard sizes and size tolerances are also indicated.

For those unfamiliar with the product, there is included a glossary of terms, a table of applications for the several grades, and suggestions for ordering plywood to prevent misunderstandings and delays.

In order to keep the commercial standard in line with progress in the production of Douglas fir plywood and with experience gained from its distribution and use, a representative committee of manufacturers, distributors, and users will, from time to time, give consideration to its revision. The personnel of this committee is listed in the publication, together with the individuals and business entities that have indicated their acceptance of the revised standard. Copies are obtainable from the Superintendent of Documents, Government Printing Office, Washington, D. C., at 5 cents each.

COMMERCIAL STANDARD FOR HARDWOOD DIMENSION LUMBER

Commercial Standard CS60–36, Hardwood Dimension Lumber, which has just been released, covers basic specifications for the production and use of wood parts of broadleafed species, in various stages of completion, which are generally referred to as hardwood dimension lumber.

This standard was established at the instigation of and in cooperation with the Hardwood Dimension Manufacturers Association. It is recognized that it may not provide a complete purchase specification for every transaction, because of the widely diversified consumer requirements; however, it does clarify the understanding between buyer and seller on most points, and unusual or more exacting needs can be appended to this specification by the purchaser.

General requirements are stipulated which cover seasoning, gluing, workmanship, and inspection, while more detailed specifications are provided for five grades of flat stock and four grades of squares, which are based on the presence of natural or manufacturing defects. Standard methods of measurement, standard dimensions, and tolerances are also included.

In a desire to acquaint the user or prospective user of dimension lumber with facts regarding it, there is included in the publication certain general information as to the recommended uses of the various grades and data excerpted from the Wood Handbook of the Forest Products Laboratory, including shrinkage and moisture content, strength values of various commercial woods, and a glossary of terms.

Following the usual custom, there is included a list of those who have indicated their written acceptance of the standard, together with the personnel of the standing committee, which is charged with revision of the standard in the light of later experience.

The standard became effective October 1, 1936. Printed copies are obtainable from the Superintendent of Documents, Government Printing Office, Washington, D. C., at 10 cents each.

RESIN IN PAPERS AND PULPS

An accurate knowledge of the amount of resinous material in papers is essential to understanding and predicting their behavior with respect to physical characteristics and permanence. Resinous material means material soluble in ethyl alcohol, and which occurs in papers by virtue of its presence in the pulps, or is added to the papers in the form of rosin to improve the writing and printing qualities.

Alcohol alone does not extract all of the rosin present in the paper. This is probably due to the fact that aluminum, added to the paper in the form of papermakers' alum, forms an aggregate with rosin or resinate ion, which must first be resolved into its components with an acid to render it alcohol-soluble. It is, therefore, necessary that the alcohol, which is to extract the rosin, contain a certain amount of

acid. Too much acid is undesirable since, under conditions of high acidity, the cellulose of the paper is attacked, resulting in byproducts which must be removed by elaborate purification procedures. A further complication arises from the fact that other substances, such as glue, starch, and casein are often present in paper; these also tend to be removed with the rosin and must be separated from it.

The principal results of certain studies described in RP973 by Herbert F. Launer in the Journal of Research for February, are as follows: (1) The official TAPPI method is shown to be undependable, owing to the lack of provision for the removal of the impurities under certain conditions, and to the use of acetic acid, which is too weak to make the alcohol sufficiently acidic. Under other conditions, the method provides for an elaborate purification procedure, which is both laborious and time-consuming; (2) a simplified method is described in which 95-percent alcohol of a certain low concentration of hydrochloric acid provides for complete extraction of the rosin, with a minimum decomposition and extraction of the cellulose and the other materials mentioned above, the rosin and other resins being then easily separated from these small amounts of impurities by the use of anhydrous ether, in which only the resins are soluble. The method is shown to be applicable to a wide variety of papers.

MOISTURE PERMEABILITY OF AIRCRAFT FINISHES

The resistance to moisture penetration of a protective coating is recognized as a fundamental property of practical importance in the prevention of intimate contact of the metal with this deteriorating agent. The problem of protecting the metal is not merely one of waterproofing, since a sound coating does not normally allow the passage of water by diffusion through holes or capillary spaces. The film behaves rather as a typical colloidal, permeable membrane, adsorbing water and transmitting it through the film by a process of chemical diffusion. In RP974 in the February number of the Journal of Research, Gordon M. Kline presents the results of a study of the permeability to moisture and some related properties of various finishes used by the Navy Department on aircraft.

The glyceryl-phthalate enamels are less permeable to moisture under relatively dry conditions than are the enamels made with a phenol-formaldehyde resin; this order is reversed, however, under wet conditions. This corresponds with the service uses to which these finishes have been found to be best adapted. The aircraft finish made with a cellulose nitrate base is very permeable to water vapor under both wet and dry conditions. It was found that the permeability is not directly proportional to the vapor pressure difference. The rate of passage of moisture per unit pressure difference increases with rising temperature. A given type of finish in contact respectively with liquid water and with air saturated with water transmits moisture at equal rates. The mechanism of penetration is, therefore, probably the same in the two cases.

Studies have shown that waxes are among the least permeable to moisture of various coating materials. The effect of carnauba wax on the permeability to moisture of films of aircraft finishes was determined in the course of the present study. The application of a coating of carnauba wax approximately 0.4 mil thick to films of 2 to 3 mils thickness has an effect on the permeability to moisture equivalent to doubling the thickness of the film.

Some observations were made on the permeability to moisture of gas-cell fabrics which had been previously tested for moisture absorption. It was found that the fabrics which contain less gelatin than the standard lightweight fabrics were less permeable in practically every test than the standard material. The permeability also decreases as the amount of paraffin is increased. Insofar as the effects of temperature and relative humidity on the rate of transmission of moisture through gas-cell fabrics are concerned, the directions of the changes are the same as were observed with paint films.

RADIO INSTRUMENTS AND MEASUREMENTS

Because of continuing demand for Circular C74, Radio Instruments and Measurements, the Bureau has arranged for reprinting of this publication, which has not been available for several years. The new issue is a reprint of the second edition of March 10, 1924, with errata indicated and obsolete appendixes omitted. The subject matter of the publication, although much of it was written 20 years ago, is of current value to radio engineers and students.

Among the subjects treated are the fundamentals of electromagnetism; the principles of alternating currents; graphical methods of solving radio circuit problems; methods of measuring radio-frequency resistance, inductance, capacity, and current; and formulas and data for the calculation of inductance, capacity, resistance, and other quantities.

The Circular has 329 pages. No free stock will be available at the Bureau, but copies can be obtained at 60 cents each from the Superintendent of Documents, Government Printing Office, Washington, D. C.

REFRACTIVITY OF WATER

The validity with which equations can represent temperature variations in the refractive index of distilled water has been investigated by Leroy W. Tilton and John K. Taylor as a preliminary to the use of such equations in adjusting and interpolating experimental data that are being used as a basis for extensive tables of the refractivity of water. Measurements of index were made at 13 equidistant points between 0 and 60° C by the method of minimum deviation using a water-jacketed hollow prism mounted in a stirred air bath on the table of a spectrometer.

Thiesen's form of density equation

$$(1-d)=\frac{(t-A)^2}{B}\cdot\frac{t+C}{t+D}$$

was transformed for use in representing refractivities, and the resulting equation was compared with 4- and 6-parameter equations written in the usual manner with powers of t, all adjustments being made by least squares with a precision of a few parts per million. Thiesen's form of equation was further tested by using it to readjust the data on density of water as observed by Chappuis at the International Bureau in 1891 and 1897. The results by these tests, which are given in the Journal of Research for February (RP971), were examined statistically and it is concluded that this type of equation is superior to a power series in t for representing the refractive index, and also the density, of distilled water.

ALPHA- AND BETA-ALDOSES

In recent years the structures of the crystalline sugars have been cleared up, but the composition of aqueous solutions of the reducing sugars is still an unsolved problem. When the sugar is dissolved in water an equilibrium is established between the alpha and beta isomers of at least two ring types, and the free aldehyde modification. The proportions of these constituents and the rates at which they change from one to another is important in elucidating the behavior of the sugars in biological and industrial processes.

The oxidation of the equilibrium solutions of the sugars proceeds rapidly until a part of the sugar is used up and then more slowly as the remaining sugar continues to be oxidized. The oxidation of the more reactive fractions takes place at rates comparable to those found for the beta sugars, while the rates for the less reactive fractions agree within reasonable experimental error with the rates for the oxidation of the alpha sugars. In recent work by Horace S. Isbell and W. W. Pigman, which is reported in the Journal of Research for February (RP969), the proportions of the rapidly and less rapidly oxidizable sugars were determined and compared with the proportions of the alpha and beta isomers calculated from the optical rotations, on the assumption that the equilibrium solutions contain only the alpha and beta normal isomers. The results of these comparisons indicate that the equilibrium solutions are principally of the normal alpha and beta sugars, but the presence of small quantities of other modifications is not excluded, especially for the solutions of galactose, arabinose, talose, and ribose. The oxidation of equilibrium solutions of *l*-ribose has revealed that they contain a small quantity of some modification which is more easily oxidizable than the crystalline sugar which was previously classified as β-*l*-ribose. The existence of this easily oxidizable modification throws doubt on the correctness of the classification of the known sugar as the beta form. The oxidation of $(d\text{-gulose})_2\ CaCl_2.H_2O$ shows that the crystalline sugar contains about 32 percent of an easily oxidizable modification which is presumably the heretofore unknown beta isomer.

Temperature coefficients were determined for the mutarotations of 20 sugars. The principal mutarotation reactions (supposedly the reversible interconversion of the normal alpha and beta isomers) are on the average 8.34 times as fast at 20° C as at 0° C, while the rapid mutarotation reaction is on the average only 5.32 times as fast at 20° C as at 0° C. The higher temperature coefficient for the principal mutarotation reaction shows that the heat of activation is greater for the intercon-

version of the normal isomers than for the rapid reaction. The mutarotations which occur after a sudden change in temperature prove that the compositions of equilibrium solutions of galactose, arabinose, and talose are altered markedly by a change in temperature. The proportions of the labile constituents, produced by the rapid mutarotation reaction, vary with temperature more than the proportions of the normal alpha and beta isomers.

HEATS OF COMBUSTION OF HYDROCARBONS

Data on the heats of combustion of organic compounds are of importance chiefly because such data are necessary in the only feasible method of determining the free energies of formation of many compounds. A knowledge of the free energy of formation of a compound is needed by the chemist to enable him to predict from thermodynamic considerations the conditions under which given reactions involving the compound may take place, and to calculate, as he will want to do, the equilibrium constants of these reactions.

While the heats of combustion of many organic compounds have been measured, most of the measurements were made a number of years ago when experimenters did not have the advantage of modern methods, or of the more nearly pure materials which are now available. Consequently, many of the older values of heats of combustion are not sufficiently accurate to permit the calculation of reliable free energy data.

RP966 in the February number of the Journal of Research describes accurate measurements made recently by R. S. Jessup, of the heats of combustion of seven organic compounds, which are members of a series of compounds known as the normal paraffin hydrocarbons, having the general formula C_nH_{2n+2}. The members of the series on which these measurements were made are those for which n has the integral values from 6 to 12, inclusive. The results obtained are believed to be accurate within a few hundredths of 1 percent.

SEPARATION OF NAPHTHENE-PARAFFIN MIXTURES

Constant-boiling fractions of gasoline normally boiling in the temperature range 130° to 170° C, and consisting of naphthene and paraffin hydrocarbons, have been successfully separated by distilling with acetic acid. The azeotropic mixtures formed by the hydrocarbons and the acid aid in separately concentrating the paraffin and naphthene groups, which, although never absolutely pure, can be separated further by other physical methods. This accomplishment is described in a paper (RP967) by Sylvester T. Schicktanz in the Journal of Research for February.

SULPHIDES IN CEMENT

Among the minor constituents of certain portland cements are small amounts of sulphides associated with compounds of manganese and iron. These latter compounds prevent the accurate determination of sulphide sulphur by the usual evolution method. A modification of this method has been effected by Harry A. Bright, in which stannous chloride is used during solution of the sample to prevent oxidation of hydrogen sulphide by the higher oxides of manganese and iron. This work is described in the February number of the Journal of Research (RP968).

ELASTIC AND PLASTIC PROPERTIES OF CONCRETE

A number of important investigations have provided information on the elastic and plastic properties of concrete. In order to obtain additional data on these properties, Arthur U. Theuer has made a series of tests to determine the effect of different temperatures within the range 26 to 123° F on the elastic and plastic deformation of portland cement concrete when subjected to sustained compressive stress. As described in RP970 (Journal of Research for February) tests were made on concretes of two greatly different strengths and under three widely different conditions of moisture content. The specimens were subjected to sustained compressive stress for periods of 3 days, deformation readings being taken both immediately before and after loading, at intervals during the 3-day period of loading, immediately after unloading, and thereafter at intervals during the 3-day period following unloading. For all tests the stress was held at what was estimated to be 20 percent of the strength of the specimens. The plastic and elastic deformation observed in this study are arbitrarily subdivided and termed as follows: The deformation that took place within 0.2 hour after the start of loading is referred to as the elastic deformation, while that part which occurred between 0.2 hour

and 72 hours after loading is termed the time deformation; the total deformation that occurred in the 72-hour period of loading, minus the total recovery that took place within 72 hours after unloading, is referred to as the residual deformation. It was found that for all three moisture conditions, saturated, semidry, and oven-dry, the modulus of elasticity decreased with an increase of temperature. When saturated or semidry, both the time and residual deformation increased rapidly with an increase in temperature. In the dry condition, the time deformation was relatively small and constant throughout the temperature range, while the residual deformation decreased slightly with an increase in temperature.

COMPRESSIVE STRENGTH OF STRUCTURAL TILE MASONRY

During the past 15 years, investigations have yielded information on the relations between the properties of masonry walls and those of the units and mortar. This information has been used by specification writers and by building code officials in the formulation of rules for design and for codes of safe construction. Data relating to the compressive strength of composite walls with brick facing and structural clay tile backing are too meager to serve as a suitable basis for formulation of rules for design. In order that advantage might be taken of more complete information on the strengths of such walls, the Housing Division, Federal Emergency Administration of Public Works sponsored an investigation of the compressive strength of structural clay tile masonry, which was carried out by D. E. Parsons and D. Watstein at the Bureau. The report on this work appears as RP972 in the Journal of Research for February.

The investigation included the testing of 6 walls, each approximately 5 ft long, 9 ft high, and 12 in. thick, and 30 wallettes, each approximately 1 ft long, 3 ft high, and 8 in. thick. The six walls were of structural clay tile with facings of brick; they were similar in all respects except the design of the tiles, there being two walls each of three different kinds of tile. The wallettes included three each of seven kinds of tile and one mortar, and three each of four kinds of mortar with the same type of tile. All of the tiles were made at one plant at the same time and of the same kind of clay, with the exception of two types of light-weight tile. Each type of tile differed from the others in the dimensions or the arrangement of the shells and webs.

The mortar used in the construction of the walls was composed of 1 part portland cement, 1 part lime, and 6 parts sand, by volume. One of the mortars used in the wallettes was a portland cement mortar with a small addition of lime, another was a cement-lime mortar with equal parts by volume of cement and lime, while the other two were mixtures of masonry cement and sand.

The walls and wallettes were tested for compressive strength after aging for approximately 2 months. The walls were tested under eccentric loading, the eccentricity being 1.15 inch. The wallettes were tested under concentric loading. Measurements of the deformations of the walls under load indicated that the compressive deformations in the backing were considerably greater than those in the facing due to the unsymmetrical structural cross section of the wall and the effects of differences in the materials in the backing and facing and of the eccentricity of the load. The deformations were not proportional to the loads, but increased more rapidly than the loads. The relation between stress and strain was similar, in this respect, to that shown in other tests of masonry containing mortars of low strength. The mortar in the bed joints of the tile backing crushed as the loads approached the maxima, the crushing of the mortar being the first sign of impending failures. The crushing of the bed joints also was the first sign of impending failure for wallettes with mortars of masonry cement and the 1:1:6 cement-lime mortar.

The average compressive strengths (gross area) of the walls ranged from 280 to 620 lb/in.^{2}, the strengths being roughly proportional to the thicknesses of the face shells of the tiles. The nearly linear relation between the proportion of the area of the tiles bedded with mortar and the compressive strength of the walls is in accord with the findings in previous investigations of the compressive strength of structural clay tile masonry. The average compressive strength (gross area) of the wallettes ranged from 450 to 1,380 lb/in^2, the strengths depending upon the design of the tiles and the strength of the mortar. In general, the strengths of the wallettes increased with an increase in the strength of the mortar, and usually were greater the thicker the face shells of the tiles, some departures from this relation be-

ing due apparently to variations in the arrangements of the shells and webs.

LENGTH CHANGES OF REFRACTORY MATERIALS IN COMPRESSION

Under the direction of R. A. Heindl, chief of the refractories section, a study has been undertaken of creep or length changes of refractory materials in compression at various temperatures over fairly long periods of time. At present nine commercial brands of refractory bricks ranging in silica content from 15 to 96 percent are undergoing such tests. At the beginning of a test at a particular temperature each specimen is placed under a load to produce an initial strain of 0.014 percent. Two gage lengths of 6 inches, diametrically opposite, were used for observing length changes. Particles of silicon carbide cemented to the specimen were used as marks for the readings. Length changes were observed with a telescope comparator and measurements were made at monthly intervals. Results obtained on one set of specimens under test for 182 days at 350° C were as follows:

Brand	Silica content	Modulus of elasticity		Change in modulus of elasticity	Increase in length[a] at end of 182 days at 350° C
		Before test	After test at 350° C		
	%	*1,000 lb/in.²*	*1,000 lb/in.²*	%	%
19	15	3,870	3,630	−6.2	0
18	37	2,750	2,810	+2.2	0
1	48	2,340	2,180	−6.8	0
6	52	1,740	1,740	0	0
11	57	524	530	+1.1	0
7	58	1,610	1,610	0	0
15	65	1,390	1,305	−6.1	0.006
16	81	274	248	−9.5	.006
17	96	517	370	−28.4	.042

[a] Based on room temperature measurements after completion of test.

During the 182-day period that the specimens were kept at 350° C no measurable creep took place. The increase in length shown in the table must, therefore, have taken place either during the heating up or cooling down of the specimens or possibly during both operations.

MOISTURE EXPANSION OF CERAMIC WHITEWARE

During the preparation of a report by R. F. Geller and Ansel S. Creamer on moisture expansion of ceramic whiteware, the question was raised as to what data were available to support the assumption of Schurecht that the difference in total thermal expansion, obtained at 400° C or at a higher temperature, in the first and second tests of specimens which have had the opportunity of reacting with moisture (either during prolonged storage or in an autoclave), is an indirect measure of expansion caused by the reaction. Since such data were not found in the literature, a brief study was made to obtain them.

The moisture expansion of a number of specimens of ceramic whiteware was measured directly, and also indirectly, by means of the interferometer, after autoclaving and after 1 year of storage in a moist atmosphere. Differences in values obtained by the two methods are no greater than differences between duplicate determinations by the direct method. The results, therefore, show that the assumption made by Schurecht is substantially correct.

LEAD-BOROSILICATE GLAZES

Metallic resistors offer decided advantages as elements in industrial kilns heated with electricity, and have found broad application in annealing furnaces, for decorating ceramics, and for producing vitreous enameled ware. However, "soft" ceramic glazes, maturing at temperatures within the heating ranges of such kilns or furnaces, either are unsuitable (for other than certain art ware) because of their high thermal dilitation and consequent propensity to crazing or, because, if the body composition is adjusted so as to "fit" the glaze, a product is obtained which is too susceptible to failure by thermal shock. This high dilitation of the commonly used soft glazes is caused by the increased content of such fluxes as K_2O, Na_2O, and CaO necessary to produce the desired maturing at or below 1,000° C.

R. F. Geller, chief of the whiteware section of this Bureau, is investigating the possibilities of two other powerful fluxes, namely, PbO and B_2O_3, which have relatively low thermal-expansion factors. The chief difficulty to be overcome is the solubility of the glaze in water and in dilute acids such as vinegar (4-percent aqueous solution of acetic acid). Compositions have been prepared over the entire PbO-B_2O_3-SiO_2 field at 10-percent intervals, and several of these have been modified by the addition of 5 percent of Al_2O_3.

In general, the expansions increase with increasing PbO or B_2O_3 content, but the relation is not linear. At a constant SiO_2 level, the addition of B_2O_3 in place of PbO at first reduces

the expansion, becoming a minimum at approximately equal PbO and B_2O_3 content, and then increases again with increase of B_2O_3. For example, at 20 percent SiO_2, the expansion to 300° C with 20, 40, 60, and 80 percent PbO is 19, 16, 17, and 27 microns per centimeter, respectively. At the 70 percent SiO_2 level, for 10 and 20 percent PbO it is 7.6 and 6.8 microns per centimeter. The addition of 5 percent of Al_2O_3 to these glasses lowers the expansion by about 10 percent in the majority of compositions, although for the glasses of very low PbO content, plus very high B_2O_3 content, the expansion is raised 5 to 10 percent.

The softening point decreases with increasing PbO and B_2O_3 content, but not in a linear manner. Most of the glasses become opalescent or opaque on cooling, only those of low B_2O_3+ PbO content, and of high PbO with low B_2O_3 content being clear. The addition of 5 percent of Al_2O_3 gave clear glasses, except with very high (60 to 80 percent) B_2O_3 content + 10 percent of PbO, and in most cases it raised the softening point somewhat, but several have been matured on talcose bodies satisfactorily at 975 to 1,025° C.

All lead-borate glasses (200 to 325 mesh) are completely dissolved by boiling in 4 percent acetic acid, while lead silicates containing over 83 percent of PbO have all the PbO extracted. At 60 percent PbO–40 percent SiO_2, only 9 percent of the PbO is extracted by this treatment and the addition of 5 percent of Al_2O_3 to this composition reduces the extraction to 1 percent; however, the addition of B_2O_3 increases the amount of extractable PbO. Example: At 50 percent SiO_2, 40 percent PbO, 10 percent B_2O_3, about 75 percent of the PbO is dissolved. At 70 percent SiO_2, 20 percent PbO, 10 percent B_2O_3, only a trace of PbO is dissolved, while at 70 percent SiO_2, 10 percent PbO, 20 percent B_2O_3, about 5 percent of PbO is extracted. The addition of 5 percent of Al_2O_3 has the unexpected effect of increasing solubility of some compositions although it usually decreased it.

GASES DISSOLVED IN GLASS

It is a well-established fact that practically all ordinary glass evolves gases when heated to a high temperature in a vacuum, and that these gases include water vapor, acid gases, such as carbon dioxide and sulphur dioxide, and elemental gases, such as oxygen and nitrogen. Although some of the gases may be present in the glass as compounds, which decomposed at high temperatures under reduced pressure, it is thought some of them are "in solution" (dissolved) in the glass as normally made.

In some cases a study of the amounts and kinds of gas dissolved in glass has assisted manufacturers in reducing the quantity of seeds (small gas bubbles) in certain kinds of glass. Since certain barium glasses, especially the barium crowns made at the Bureau for optical purposes, almost invariably contain seeds, A. N. Finn, chief of the glass section, has been studying the amounts and kinds of gases dissolved in barium crown glasses with the idea of developing a method for their elimination.

The apparatus consisted essentially of an induction furnace in which the samples were heated, an automatic Toepler pump for collecting the gases, and a weight burette for determining the volumes of gas. Gases in three kinds of optical glass were determined—a borosilicate crown (n=1.517), which is usually easily made free from seeds; a light barium crown (n=1.574), which is normally seedy; and a light crown (n=1.524), which usually contains a few seeds. Gases were also determined in samples of window glass, whose batch composition is comparable with that of the light crown, except that salt cake may be used in the window-glass batch.

The amount of water vapor obtained from all the glasses was, in general, of the same order of magnitude—25 ml per 100 g of glass (the water being regarded as a perfect gas at normal temperature and pressure). The amounts of acid and elemental gases found in the optical glasses varied somewhat, but were, generally, practically negligible when compared with the amounts of similar gases obtained from window glass. For instance, the acid gases obtained from the borosilicate and light barium crowns never exceeded 1 ml per 100 g and the elemental gases were always less than 2 ml; from the light crown, the acid and elemental gases obtained were about 4 ml each. However, the amounts of the same gases obtained from the window glasses were about 35 and 25 ml, respectively.

The small volumes of acid gas obtained from the optical glasses may result from the absorption of most of the carbon dioxide by the volatilized basic oxides which condense on the colder areas of the furnace walls, before the acid gas reaches the measuring system,

but it is not thought the difference between the amounts of condensed alkali from the optical and window glasses is sufficient to explain the large difference in the amounts of gas obtained. It is probable, however, that optical glasses actually contain less dissolved gas than window glass because the former are vigorously agitated by mechanical stirring for several hours after the batch is melted, while window glass is not subjected to such treatment.

Gas determinations made on samples of optical glass taken during stirring indicate that the excess of dissolved gas must be removed very early in the process, because no significant difference in the amount of gas was found in samples taken periodically after the first hour of stirring.

The relatively small amount of gas obtained from the optical glasses compared with that from window glass indicates that there is probably no relation between the dissolved gases and prevalence of seeds in the light barium crown glass.

TESTS OF AUTOMATIC FIRE-ALARM SYSTEMS

At the request of the Bureau of Marine Inspection and Navigation, tests of automatic fire-alarm systems and their component parts were begun under the direction of S. H. Ingberg of this Bureau in 1930 to establish bases of requirements for design, materials, and performance, and to determine the acceptability of devices submitted for approval under such requirements. By act of Congress, this type of protection has been required for new passenger, or freight and passenger, vessels since 1916. The results of the tests have also been used in formulation of specifications for equipment and details of installation as required for Government buildings.

The thermosensitive element is the most essential portion of the automatic fire-alarm system, since the protection afforded depends largely on its prompt and reliable operation. The general types of automatic fire-detecting elements can be divided into two general classes, fixed-temperature elements and rate-of-rise elements, with subdivisions within each.

Fixed-temperature elements. — This type of element actuates the alarm when its temperature reaches a certain degree which, for ordinary temperature rises, means a considerably higher surrounding air temperature. One of the oldest is the fusible-alloy type, such as the soldered link and the strut-type automatic sprinkler head. As adapted to thermostatic elements other than sprinklers, the alloy has been placed in the form of a disk between a metal plate on one side and a perforated insulating plate on the other, fusing of the disk causing the perforations to fill and an electrical contact to be established. This type of thermosensitive element has also been placed to form the core of a slotted steel sheath insulated from an outer copper sleeve by means of servings of insulating thread. The melted alloy core issues through the slot in the sleeve and makes an electrical contact between it and the copper outer sleeve. The whole assembly is insulated and protected with braid and is generally known as thermostatic wire. In other forms of spot thermostats the fusing of the solder under tension from springs opens or closes electrical circuits.

Recently, there have been developed some hard compounds with sharply defined melting temperatures lower than the standard sprinkler solders, that have been applied in automatic sprinkler heads and, to a limited extent, in thermostats.

The bimetallic thermostat is actuated by the deflection of a bimetallic strip, which causes an electrical contact to be made or broken. In a recent form the strip is inclosed in a glass tube filled with hydrogen, which serves as a protection against corrosion or tampering.

In the mercurial thermostat the contact is made by the mercury column, which rises and contacts wires embedded in the glass and projecting into the capillary. Another thermosensitive element consists of a silica glass bulb filled with a liquid that expands with temperature sufficiently to disrupt the bulb, thus making or breaking an electrical contact. The temperature of operation is adjusted by varying the size of a vapor bubble within the bulb.

Rate-of-rise elements.—Among rate-of-rise elements the pneumatic type has perhaps been more widely used than any other. Its operation depends on the expansion from the heat of the fire or air within a vent-compensated system, which deflects diaphragms forming one side of connected air cells, to make an electrical contact instrumental in sounding the alarm. The operating pressure and vent are so adjusted that pressures built up from ordinary temperature changes will not cause false operation of the system. The air volume concerned can be contained in long runs of fine tubing or can be consoli-

dated in clusters of tubing or in bulbs of relatively large volume.

Another rate-of-rise element is of the thermopile type in which an electromotive force is created by a temperature rise between the exposed and protected ends of several thermocouples in series. If the rate of temperature rise is sufficiently slow, the protected and unprotected junctions will be at nearly the same temperature and accordingly no electromotive force sufficient to actuate the alarm will be produced. However, if the rate-of-rise exceeds a certain limit, the temperature difference will create an electromotive force sufficient to operate the relay connected with the alarm.

Other types of rate-of-rise elements depend on the relative expansion of rods of different diameters, or on the relative deflection of bimetallic strips of different thicknesses or with different amounts of heat insulation or shielding. These are also proportioned or adjusted so that normal temperature rises will not cause false alarms.

Combined fixed-temperature and rate-of-rise elements.—The expansion and bimetallic type rate-of-rise elements can be equipped with additional contacts so as to operate at given fixed temperatures irrespective of the rate of rise. Accordingly, operation is assured even though the rate of rise is insufficient to cause contact between the two elements of the rate-of-rise device.

Types of systems.—For one type of system the thermosensitive elements are placed in parallel between the two portions of the circuit, with contacts normally open. On being actuated by fire, the contacts close, thereby operating the alarm devices. For automatic supervision over this type of circuit, a high resistance is placed at the ends of line conductors between the two sides of the circuit, thus enabling a small supervisory current to flow without actuating the fire-alarm relay but which is sufficient to energize a trouble relay also in the circuit. If any break occurs, the trouble relay is deenergized, making an electrical contact and giving a trouble signal. For an ungrounded electrical source of energy, a single ground will not give either a fire alarm or trouble signal. The power source can, however, be grounded through a high resistance to give a trouble signal for a ground on either side of the circuit. For grounds on both sides of the circuit, a fire alarm is given.

In another type of circuit the thermosensitive elements are connected in series with the line conductor, and a high-resistance relay is introduced to limit the normal current flow. The thermostats on being actuated open the circuit which deenergizes the relay and causes an alarm. The power source may be connected to ground through a high resistance, and relays introduced to give trouble signals for grounds at any point in the circuit. An accidental break will cause a fire alarm to be given. If the conductors of a loop are shorted on each other, neither a trouble nor a fire-alarm signal will be given, and the operation of a thermosensitive element located between such points will not give a fire-alarm signal. The possibility of this occurrence can, however, be made remote if the wiring is properly insulated.

Other types of circuits for automatic fire-alarm systems have been devised consisting of two or more loops whereby fire-alarm signals will be transmitted, even if one or two lines are broken. This is effected through the trouble relays which, when actuated, automatically cause circuit adjustments to be made whereby the alarm can be received through the unbroken portions of the circuit. This adjustment can also be made manually on receipt of the trouble signal.

Local alarms consist of one or more independent units that contain all parts needed for detection and alarm. By means of some form of thermosensitive element, usually of the fixed-temperature type, a bell, whistle, or buzzer, located within the unit and operated by spring tension or from the electrical supply of the building, is actuated. The usefulness of this type of system is limited by the relatively small range within which the alarm can be received. It would be almost totally ineffective in unoccupied buildings. As applied, for instance, in two-story dwellings, a local alarm located in the basement should arouse sleeping occupants on the second floor.

Electrical tests.—Thermosensitive elements connected with electrical circuits are generally given a breakdown voltage test of 1,000 volts, plus the operating voltage. Other tests to determine the electrical insulation afforded are also applied, depending on the nature of the device.

Relays are required to withstand operation tests involving 50,000 repetitions without appreciable deterioration. Bell wiring is subjected to the electrical breakdown tests. Electrical-insulation tests are applied to the whole system after installation.

Tests for mechanical damage and vibration.—Tests are made to deter-

mine the susceptibility of parts, such as thermosensitive elements, to mechanical damage, particularly damage that renders them inoperative without giving any automatic or readily observed indication of this condition. Vibration tests are made to determine susceptibility to false alarms under the intended conditions of service.

Corrosion tests. — Thermosensitive elements are subjected to corrosive atmospheres, salt sprays, etc., to determine how these affect reliability and sensitivity of operation.

Determining the temperature of operation.—The temperature of operation of fixed-temperature thermosensitive elements is determined in air, oil, or water baths, the temperature rise within or near the operating range being not more than 1° F/min. In general, the most accurate determinations can be made with the oil bath. As an indication of proper control in manufacture and to avoid unduly high or low operating temperatures, a limit of 5° F above or below the rated operating temperature has been applied for fixed-temperature elements.

Sensitivity test.—The object of the sensitivity test is to determine on a comparative, if arbitrary, basis the sensitivity of response of thermosensitive elements to temperature rise. The equipment and method of conducting the test must be chosen so as to avoid: (1) Variations in results caused by thermal lag of the temperature-indicating instruments, and (2) effects from radiation and air convection in the oven in which the tests are made. In tests as conducted at the Bureau, the temperature is measured with thermometers or thermocouples having known coefficients of thermal lag. Direct effects of radiation from the heating elements of the oven are largely obviated by providing screens between the thermosensitive element and heating coils. Free natural convection obtains within the oven and no recourse is made to fans or other methods of providing artificial convection. This is done on the assumption that an actual fire may not be in a location where there would be direct radiation on the thermosensitive elements, or the radiation may be effectively absorbed by smoke. Since thermosensitive elements as a rule are not symmetrical on all sides from the standpoint of sensitivity to temperature response, it is believed that mounting the element on the ceiling of the oven, in which the air circulates by natural convection currents only, probably simulates average fire exposure conditions.

In conducting a test, the oven temperature is raised slowly to about 99° F, after which more current is applied, the door is closed, and test started when the temperature reaches 100° F. The rise in the oven is regulated by thermocouples, points on the thermocouple control curve and corresponding points on the thermometer curve being given in the following table. The reference thermometer is Tycos 7A539584, 750° F, lag coefficient in still air, 2 min, 15 sec. Stem 15½ inches long, $\frac{9}{32}$ inch diameter. Bulb ¾ inch long, $\frac{11}{16}$ inch diameter.

Time	Reference thermometer	No. 24 gage thermocouple
min:sec	°F	°F
0:00	100	100
0:30	127	171
1:00	150	205
1:30	172	228
2:00	190	242
2:30	205	252
3:00	218	261
3:30	227	269
4:00	235	276
4:30	243	283
5:00	250	289
5:30	255	294
6:00	• 260	• 300

• Above this the rate of rise is 10° F per minute.

For testing rate-of-rise elements, the same oven is employed but the temperature rise is made as nearly linear as possible. Tests are made with different rates down to the point where no operation is obtained.

In the above tests, fixed-temperature elements are required to operate within 3½ minutes. The settings of pneumatic tube, rate-of-rise elements are required to be made so that under conditions least favorable for response (minimum length or percentage of tubing exposed at locations most remote from diaphragms), operation will take place on rates of rise of 40° F per minute or less, and under conditions most favorable for response (maximum length or percentage of tubing exposed in portions of circuit near diaphragms), no operation will occur with rates of rise of 4° F per minute or less.

Tests of systems.—Operation tests have been made of the systems, with thermosensitive elements placed on the ceilings of rooms from 140 to 1,000 ft^2 in area. Alcohol in pans of different sizes, and wood, excelsior, and paper in

piles are used as fuel for the test fires. The tests are designed to give information on the performance of the whole system and on requirements for sensitivity and spacing of thermosensitive elements.

General results.—Very few failures have occurred in the electrical tests. In the mechanical breakage tests some weaknesses have developed, which can generally be corrected by changes in material and design. A number of the devices failed in the corrosion tests, but passed after changes had been made in material, or protective coatings had been applied to such parts as contact points and surfaces of bimetallic elements. With suitable control in manufacture, the temperature of operation of elements of the fusible solder, bimetallic, and mercurial types, will come within the required tolerance. The silica glass bulb elements had, in general, the widest range. Many rejections in the initial tests were due to lack of sensitivity. By changes in design to obtain fuller exposure of the heat-actuated element, in the material and dimensions, and in the operating temperature, it was possible for most devices to meet this requirement. Lowering the operating temperature increases the sensitivity, the permissible range of which is taken to be 135 to 165° F for locations where room temperatures do not exceed 100° F. Higher operating temperatures are required where higher room temperatures prevail, but the sensitivity requirement is waived provided the device meets the requirement with the lower operating temperature.

NEW AND REVISED PUBLICATIONS ISSUED DURING JANUARY 1937

Journal of Research [1]

Journal of Research of the National Bureau of Standards, volume 18, number 1, January 1937 (RP957 to RP965, inclusive). Price 25 cents. Obtainable by subscription.

Research Papers [1]

[Reprints from the October and November 1936 Journal of Research]

RP925. Harmonic method of intercomparing the oscillators of the national standard of radio frequency. Evan G. Lapham. Price 5 cents.

RP926. Temperature compensation of millivoltmeters. Herbert B. Brooks. Price 10 cents.

RP927. Time factors in the ionization of carbon disulphide by X-rays. Lauriston S. Taylor. Price 10 cents.

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RP929. Calculations of electrical surge-generator circuits. Arthur B. Lewis. Price 5 cents.

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RP944. Estimation of chromaticity differences and nearest color temperature on the standard 1931 ICI colorimetric coordinate system. Deane B. Judd. Price 5 cents.

Commercial Standards[1]

CS45–36. Douglas fir plywood (domestic grades). (Second edition.) Price 5 cents.

CS45E–36. Douglas fir plywood (export grades). Price 5 cents.

CS60–36. Hardwood dimension lumber. Price 10 cents.

Technical News Bulletin[1]

Technical News Bulletin no. 237, January 1937. Price 5 cents. Obtainable by subscription.

MIMEOGRAPHED MATERIAL

Letter Circulars

Letter Circulars are prepared to answer specific inquiries addressed to the National Bureau of Standards, and are sent only on request to persons having definite need for the information. The Bureau cannot undertake to supply lists or complete sets of Letter Circulars or to send copies automatically as issued.

LC486. Metals do not "crystallize" under vibration. (Replaces LC204).

LC487. Nomenclature of copper alloys—brass and bronze. (Replaces LC268.)

Technical Information on Building Materials

The supply of these notes, each of which consists of three or four pages giving the important facts on some one aspect of the properties or use of building materials, is necessarily limited. Their distribution will be confined to Government officials concerned with building projects, and to architects, engineers, and home builders. Requests should make clear the actual need for the information at the time of writing. Letters should be addressed to the Division of Codes and Specifications, National Bureau of Standards, Washington, D. C. The following note was issued since the list published in the January 1937 number of the Technical News Bulletin:

TIBM–43. Aluminum paints.

RECENT BUREAU ARTICLES APPEARING IN OUSTIDE PUBLICATIONS[2]

Direct effects of particular solar eruptions on terrestrial phenomena. J. H. Dellinger. Phys. Rev. (11 East 38th Street, New York, N. Y.) **50**, 1189 (December 15, 1936).

Underground corrosion. K. H. Logan. Trans. Am. Soc. Civil Engrs. (29 West 39th Street, New York, N. Y.) **101**, 811 (1936).

Extraction, with acetone, of substantially constant-boiling fractions of a "water-white" lubricating oil. B. J. Mair and S. T. Schicktanz. Ind. Eng. Chem. (706 Mills Building, Washington, D. C.) **28**, 1446 (1936).

Relationships between the physical properties and chemical constitution of lubricating-oil fractions. B. J. Mair and C. B. Willingham. Ind. Eng. Chem. (706 Mills Building, Washington, D. C.) **28**, 1452 (1936).

The chemical constituents of lubricating oil. Frederick D. Rossini. Proc. Am. Petroleum Inst. (250 Park Ave., New York, N. Y.) **17** (III) (1936). Oil Gas J. (Tulsa, Okla.) no. 26, 146 (1936); Refiner Natural Gasoline Mfr. (3301 Buffalo Drive, Houston, Tex.) **15**, 499 (1936).

Color of abaca fiber in relation to deterioration by weathering. Genevieve Becker. Cord Age (114 East 32d Street, New York, N. Y.) **28**, no. 6, 24 (December 1936).

Stability of motion picture films as determined by accelerated aging. C. G. Weber and J. R. Hill. J. Soc. Motion Picture Engrs. (33 West 42d Street, New York, N. Y.) **27**, 677 (December 1936).

Care of filmslides and motion picture films in libraries. J. R. Hill and C. G. Weber. J. Soc. Motion Picture Engrs. **27**, 691 (December 1936).

Air conditioning requirements of multicolor offset printing. C. G. Weber. Refrigerating Eng. (37 West. 39th Street, New York, N. Y.) **32**, 393 (December 1936).

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